Case: GTM

Gerhard Thien

Frankfurter Chaussee 49
D-15848 Beeskow

LIFT MOTOR

Ins. A' a'7

LIFT MOTOR ~~Description~~

The invention relates to an apparatus for generating a torque.

Such apparatuses are required in many ways in the art, in particular as drives for machinery and the like.

The object of the invention is to provide a further apparatus of the type named initially which, in particular, uses buoyancy forces to generate a torque.

This object is achieved by the apparatus according to Claim 1.

According to the invention, therefore, at least two bodies () are coupled to one another in such a way that they can perform a rotational movement, in which one body moves in the direction of the force of gravity and the other in the direction opposite thereto, each body, when changing the direction of movement, altering its volume so that the volume of the body or bodies moving in the direction of the force of gravity is less than that of the bodies moving in the opposite direction.

The way in which the volume of each body changes, therefore, is that it is increased when its downward movement, in other words essentially its movement in the direction of the force of gravity, changes into an upward movement, in other words a movement counter to the force of gravity, while it diminishes as soon as the movement of the body once again changes to the downward movement. This alternating increase and decrease in the volume of the bodies when the direction of movement changes ensures that the bodies moving upwards at any given time, because of their greater volume, experience greater buoyancy than the downward-moving bodies. The rotational movement of the bodies is produced thereby.

It is particularly advantageous if the two bodies coupled to one another are so designed that,

despite the alternating changes of volume of the individual bodies, the total volume of all bodies is substantially constant.

Although the apparatus according to the invention can also, in principle, be operated with an uneven number of bodies, provision is preferably made for the bodies to be arranged opposite one another in pairs relative to the rotational movement. A particularly uniform generation of torque is ensured by this symmetrical arrangement of the bodies in pairs.

In principle, the apparatus according to the invention can be operated in any fluid which, with practicable changes in the volumes of the bodies, supplies a sufficiently large increase in buoyancy for at least the frictional forces acting in the apparatus to be overcome. Preferably, however, provision is made for the bodies to be immersed in a liquid during at least part of their rotational movement. As a result of the at least partial but expediently complete arrangement of the apparatus in a liquid, especially in water, a relatively large increase in buoyancy can be achieved even with a relatively small change in volume. For example, an increase in the volume of individual bodies by in each case 1 dm^3 (1 l) supplies an increase in buoyancy of 9.81 N (1 kp).

It is particularly expedient if the individual bodies are connected to one another by a tension member which runs in an annular manner over at least one deflection device, the deflection device having at least one deflection wheel which is mounted on a shaft from which the torque can be taken off.

In order to use as much as possible of the difference in buoyancies to generate torque, provision is made for each set of two bodies assigned to one another as a pair, preferably all bodies, to have the same dimensions. In this manner, the apparatus can be kept completely in equilibrium with regard to the weights acting on it.

In a particularly preferred embodiment of the invention, each body is designed as a piston-and-cylinder unit, the piston being movable into its extended or retracted position by the weight acting on it as a function of the orientation of the piston-and-cylinder unit relative to the force of gravity.

In order to ensure, in this arrangement, that the displacement of the piston, especially its extension movement, can take place solely on the basis of the weight acting upon it, the piston length l_k satisfies the following equation:

$$l_k \geq h \cdot \frac{p_f}{p_k}$$

where h is the maximum depth of immersion of the body into the liquid, p_f is the density of the liquid and p_k is the density of the piston material.

It is particularly expedient if the individual piston-and-cylinder units are arranged so that each piston-and-cylinder unit, in the event of a change in direction of movement, is automatically transferred from its one position, in which the piston is extended or retracted, into its other position, in which the piston is, respectively, retracted or extended.

In a further embodiment of the invention, the cylinder chambers of the individual piston-and-cylinder units are connected to one another in order to permit a fluid exchange, the cylinder chambers being connected to one another in an annular manner, preferably via a hose.

In this manner, a self-contained fluid system can be formed in the cylinder chambers connected to one another, the effect of which is that the pressure created by the retraction of a piston changing to downward movement can be output via the self-contained fluid system to the piston of the piston-and-cylinder unit which is changing over to upward movement, which piston is moving out into its extended position, so that an additional pressure on the piston assists its

movement into the extended position in order to increase the volume and compensate for any frictional losses arising.

The fluid used in the cylinder chambers may be simply air or another gas; it is also possible, however, for example, to use a very light oil or a similar liquid as a fluid, which has the advantage that the pressure can be transferred particularly well.

The invention is explained below by way of example with reference to the drawing, in which:

Figure 1 shows a greatly simplified diagrammatic representation of an apparatus according to the invention having a pair of bodies to generate a buoyancy difference,

Figure 2a shows a simplified diagrammatic sectional representation of a piston-and-cylinder unit with the piston extended,

Figure 2b shows a simplified diagrammatic sectional representation of a piston-and-cylinder unit with the piston retracted, and

Figure 3 shows a simplified diagrammatic representation of an apparatus according to the invention with a plurality of bodies for generating a buoyancy difference, arranged in pairs.

In the figures of the drawing, components which correspond to one another are provided with identical reference numbers.

As Figure 1 shows, the apparatus according to the invention for the generation of a torque comprises a deflection device 10 for a tension member 11 to which two piston-and-cylinder units 12 are attached as a pair of bodies for generating a buoyancy difference. The deflection device 10 comprises a deflection wheel 13, which is mounted on a shaft 14, from which the torque generated by the apparatus according to the invention can be taken off. For example, a generator for the generation of electrical energy may be connected to the shaft 14.

As a deflection wheel 13, depending on the tension member 11 used, it is possible to use a toothed wheel or a cable drum or the like. Correspondingly, the tension element 11 can be designed as a chain, cable, toothed belt, tension belt or the like.

In order to transmit to the tension member 11 the forces acting on the piston-and-cylinder units 12, each piston-and-cylinder unit 12 is held on the tension member 11 by means of fixing pins 15 or the like set at a distance apart in the longitudinal direction of the tension member 11.

As a result of this fixing of the piston-and-cylinder units 12 on the tension means 11, that is to say as a result of the fixing means set at a distance apart in the longitudinal direction of the tension means 11 and thus in the direction of movement of the piston-and-cylinder units 12, what is achieved is that the piston-and-cylinder units 12 retain the same orientation relative to the respective direction of movement throughout the rotational movement, so that when the direction of movement is changed relative to the force of gravity they automatically alter their position relative to gravitation.

In order to connect the cylinder chambers 16 of the piston-and-cylinder units 12 to one another, so that the latter communicate with one another, a hose 17 or similar connection is provided as a fluid line and is fixed via corresponding connection pieces 18 and connectors 19 to the cylinders 20 of the piston-and-cylinder units 12, so that the hose 17 is in fluid connection with the respective cylinder chambers 16.

As shown in detail in Figures 2a and 2b, a piston 21 is slidingly arranged in each cylinder 20 so that if the cylinder 20 is arranged as shown in Figure 2a, with its open side downwards, it slides downwards into its drawn-out or extended position as a result of the weight acting upon it. In order to prevent the piston 21 from falling out of the cylinder 20 during

weight from liquid 2,

this, the cylinder 20 has, for example, an inward-directed flange 22, while the piston 21 bears an outward-directed flange 23 interacting with the former. Arranged on the flange 22 are sealing means, not shown in detail, which seal off the cylinder chamber 16 in a gastight manner without substantially impeding the displacement movement of the piston 21, in order to ensure that the medium surrounding the piston-and-cylinder unit 12 cannot penetrate into the cylinder chamber 16.

In what follows, it is assumed that the apparatus according to the invention is completely arranged in water and that the cylinder chambers 16, which are connected to one another via the hose 17 and form a self-contained fluid system, are filled with air. Instead of water, another medium may also be used, having a low viscosity and the highest possible density. When water is used, as is assumed here, the lightest possible oil may be used instead of air as the fluid filling the cylinder chamber 16. An essential factor for the selection of the flowable media provided in the apparatus according to the invention is that the density of the medium provided in the cylinder chambers 16 should be less, preferably very much less, than that of the medium surrounding the piston-and-cylinder units 12.

The density difference between air and water is so great that, in the explanation of the invention which follows, the mass of the air contained in the cylinder chambers 16 can be disregarded completely.

In order to ascertain the resulting force F_R transmitted via the tension member 11 to the periphery of the deflection wheel 13 in order to generate the torque, the forces acting on the piston-and-cylinder units 12 will initially be considered individually. Acting on the piston-and-cylinder unit 12 shown on the left in Figure 1, in addition to its weight G_1, is the buoyancy $F_A(V_1)$ generated by the surrounding water which

brings about an apparent reduction in the weight G_1. The buoyancy depends in a known manner on the volume V_1 of the piston-and-cylinder unit 12 shown on the left in Figure 1 and is calculated by the equation $F_A(V_1) = g \cdot p_f \cdot V_1$. In this case, g is the acceleration due to gravity and p_f is the density of the medium surrounding the piston-and-cylinder units 12, in other words water.

Correspondingly, the piston-and-cylinder unit 12 shown on the right in Figure 1 is subjected not only to the weight G_r acting upon it but also to the buoyancy $F_A(V_r)$, which satisfies the equation $F_A(V_r) = g \cdot p_f \cdot V_r$, V_r being the volume of the right-hand piston-and-cylinder unit 12, in other words the piston-and-cylinder unit 12 with the piston 21 retracted.

Bearing in mind the fact that the forces transmitted from the left-hand and right-hand piston-and-cylinder unit 12 to the tension member 11 act in opposite directions relative to the tension member 11 and the buoyancy in each case acts contrary to the force of gravity, the following equation is obtained for the resultant force F_R:

$$F_R = F_A(V_1) \cdot F_A(V_r) + G_r - G_1$$

With the above equations for the buoyancy forces, the following equation is then obtained for the resultant force F_R:

$$F_R = g \cdot p_f \cdot (V_1 - V_R) + (G_r - G_1)$$

If, then, as is preferably provided in this invention, the piston-and-cylinder units 12 are designed in the same way, so that they also have the same weight, the weights cancel each other out and the resultant force F_R acting on the deflection wheel 13 in order to generate the torque at the shaft 14 then depends only on the volume difference $\Delta V = V_1 - V_r$

between the two piston-and-cylinder units 12. The volume difference ΔV corresponds, in the case of a cylindrical piston 21, to the product of the piston stroke l_h and the cross-sectional area of the piston A_k. The following then applies for the resultant force F_R:

$$F_R = g \cdot p_f \cdot l_h \cdot A_k$$

In order to ensure that the piston 21 can be displaced into its extended position against the force acting on its free surface area 21', an upward force in Figure 2a, which is brought about by the water pressure prevailing in each case, the piston length l_k is preferably selected so that it satisfies the following equation:

$$l_k \geq h \cdot \frac{p_f}{p_k}$$

In this equation, h is the maximum possible depth of immersion of the piston-and-cylinder unit 12, and hence of the piston 21, in other words the distance between the lowest position of the free surface area 21' of the piston 21 and the water surface, and p_k is the density of the piston material.

The function of the apparatus according to the invention will now be explained in detail with reference to Figure 3, which shows an example of embodiment of the invention having 14 piston-and-cylinder units 12 in each case arranged in pairs with one another. In addition to the upper deflection device 10, this apparatus has a lower deflection device 13 with a deflection wheel 33 which is arranged on a lower shaft 34.

As can be seen in Figure 3, the six piston-and-cylinder units 12 arranged on the left-hand side each have a volume which is greater by $\Delta V = V_l - V_r = l_h \cdot A_k$ than the piston-and-cylinder units 12 arranged on the right-hand side, since in their case the pistons 21 are

in the extended position. As a result of this, a resultant force F_R acting on the tension member 11 is, disregarding frictional losses and the like, $6 \cdot g \cdot p_f \cdot \Delta V$. This force F_R causes the piston-and-cylinder units 12 to make a rotational movement, in which the piston 21 of each piston-and-cylinder unit 12.2a, which unit alternates from the upward movement on the left-hand side to the downward movement on the right-hand side, is pushed solely as a result of the weight acting upon it into the cylinder 20 in order to reduce the volume. At the same time, a piston-and-cylinder unit 12.2b in the region of the lower deflection device 30 alternates from the downward movement on the right-hand side to the upward movement on the left-hand side, the piston 21 moving out from the cylinder 20 to enlarge the volume as a result of the weight acting upon it, against the water pressure prevailing in this region.

Since each set of two piston-and-cylinder units 12 are assigned to each other as pairs, so that they are arranged opposite each other relative to the rotational movement, such as the top and bottom piston-and-cylinder units 12.1a and 12.1b or the piston-and-cylinder units 12.2a and 12.2b, the pushing-in of a piston 21 takes place on each occasion, in other words on the change from the position of the piston-and-cylinder unit 12.1a to that of the piston-and-cylinder unit 12.2a, while on the corresponding change from the position of the piston-and-cylinder unit 12.1b to that of the piston-and-cylinder unit 12.2b, the piston is moved out. As a result of the compression of the air volume in the cylinder chamber 16 of the piston-and-cylinder unit 12.2a, which results in an increase in the air pressure within the self-contained system, the extension of the piston 21 of the correspondingly opposite piston-and-cylinder unit 12.2b is assisted.

On the assumption that, for example, steel having a density of 7.87 kg/dm^3 is to be used as the material for the piston 20 of the piston-and-cylinder

unit 12 and the apparatus is arranged at its lowest point about 2 m deep in water, a piston length l_k of about 25 cm is necessary. If, accordingly, a piston having a diameter of, for example, 22 cm and the necessary length of 25 cm is used, and is capable of performing a piston stroke of 20 cm, a volume change ΔV of about 4 dm^3 is obtained, which results in a buoyancy of about 40 N (corresponding to 4 kg of compressed water). With six such piston-and-cylinder units, then, a resultant force F_R of 235 N is obtained which, depending on the diameter of the deflection wheel 13, generates a corresponding torque at the shaft 14 which could be used to drive a generator for the generation of electrical energy.

By suitable selection of materials and appropriate sizing of the individual components of the apparatus according to the invention, torques over a wide range can be achieved in a simple manner.